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Preliminary Results

Health Study of Airborne Manganese (Mn) Exposure in East Liverpool, Marietta and Mt. Vernon, Ohio

Purpose

Workplace studies of occupations such as mining and welding show that high airborne Mn inhalation exposure can result in nervous system health effects. To date, there have been very few studies of health effects from airborne Mn exposure in community settings on adults. The main purpose of this study was to evaluate whether nervous system health effects (neurotoxicity) were detectable in community residents with long-term, airborne Mn exposure.

Background

In February 2008, the Ohio EPA completed an air quality study in East Liverpool which indicated residents were at risk from exposures to airborne manganese (Mn) and chromium. Ohio EPA identified the S.H. Bell Company, a raw products storage and packaging facility, as the source of Mn and chromium sampled in community air monitors. The Director of the Ohio EPA petitioned the Agency for Toxic Substances and Disease Registry (ATSDR) to evaluate potential health impacts.

In November 2010, ATSDR completed a Health Consultation which concluded that the levels of airborne Mn in East Liverpool exceeded both background levels and health-based guidelines. ATSDR stated that exposure to Mn concentrations in East Liverpool poses a public health hazard.

Summary of Preliminary Results

- Both Marietta and East Liverpool have elevated Mn air concentrations, but health effects potentially consistent with Mn exposure were fewer and more subtle than in worker studies with much higher exposures.
- Study results suggest that living closest to the Mn source for a longer time (i.e., more Mn air exposure) was associated with borderline to mild tremors and slightly lower motor speed and strength.

Approach

In August 2009, a Mn health study was conducted in Marietta (a community near a smelter emitting Mn) and Mount Vernon (a community without a large airborne Mn source), Ohio. The study conducted in East Liverpool in November 2011 followed a similar protocol so that data from all three communities can be compared.

Adults in each community between the ages of 30-75 were selected at random whenever possible. The data collected from the three communities included a general health questionnaire, blood test, neurological and mood assessments, and neuropsychological tests.

Blood Tests

Blood was analyzed for heavy metals including levels of Mn, cadmium, lead and mercury. Blood samples were also analyzed for levels of serum ferritin – an indicator of iron stored in the body.

Neurological Assessments, Neuropsychological Tests, and Mood

A test battery of assessment tools was used to measure cognitive flexibility (switching categories), information processing, working memory and attention, visual tracking speed, verbal skills, motor dexterity and strength, postural sway and tremors. Each of these test results yield important information about the brain function of study participants that can be used to evaluate the potential impact of Mn exposure.

Air Modeling

The concentration of Mn in air outside the homes of study participants was estimated using an EPA air dispersion model and measurements of Mn air concentrations at several fixed locations. These estimates, along with the distance from the source and the years of residency were used to calculate an "exposure index" for each resident. This exposure index was used to estimate inhalation exposure to airborne Mn.

Preliminary Results

No statistical differences were noted between residents of East Liverpool, Marietta and Mount Vernon communities for:

- General health categories (e.g., number of good, bad health days per month, smoking status, obesity, etc.)
- Amount of Mn consumed in diet (Mn is an essential nutrient and is found in many leafy green vegetables and beans)
- Blood Mn levels – the average blood Mn level in general population ranges 4-15 µg/L. The levels in each town were: in East Liverpool 10.32 µg/L; In Marietta 9.65 µg/L; and Mount Vernon 9.48 µg/L
- Blood lead and serum ferritin levels

- Neurological assessment testing: Activities of Daily Living (the things we normally do to care for ourselves, such as eating, bathing, dressing, grooming, work, etc.) and motor (movement) scores
- Neuropsychological tests: tests of attention and memory tests
- Mood tests: mood disturbance (depression, bipolar disorder, etc.)

Statistical Differences were noted between the three communities for:

- **Blood:** East Liverpool residents had higher average blood cadmium levels than Mount Vernon residents, but they were still within the normal range found in the general population. East Liverpool residents had lower blood mercury levels than Marietta residents.
- **Neurological assessment:**
 - East Liverpool residents showed slower movement initiation (results in delays in onset of movement) than Mount Vernon residents, but were slightly better than Marietta residents.
 - More hand tremors (involuntary shaking) were observed in East Liverpool residents than Marietta residents.
 - East Liverpool residents had more postural sway/instability (involuntary swaying or instability when standing on both feet) than Marietta and Mount Vernon
- **Neuropsychological tests:**
 - Scores in all three communities were within normal range, except for divided memory, visual memory, and motor speed.
 - East Liverpool residents had lower scores for immediate memory (daily living) than Marietta
 - East Liverpool residents had lower scores than Marietta and Mount Vernon for word reading, motor speed, motor strength and motor tactile.

Exposure Index

The combined data from East Liverpool and Marietta showed that residing a shorter distance from a manganese source and having a higher exposure index were related to lower neuropsychological and motor performance. The strongest effects were seen for tremor, motor speed, and motor strength.

Conclusions

- Both Marietta and East Liverpool had significant airborne Mn exposures, but health effects potentially due to Mn exposure were fewer and more subtle than in occupational (worker) studies with much higher exposures.
- An association between low test scores, distance from the Mn source, and exposure index (combining East Liverpool and Marietta), suggests that living closest to the Mn source results in higher inhalation exposure and lower neuropsychological performance. East Liverpool residents lived closer to the Mn source than Marietta residents, which may have lead to

higher Mn exposures that correlate with lower motor speed and strength in these study participants.

Actions taken to reduce ambient Mn concentrations

Ohio EPA has identified the S.H. Bell facilities as the source of airborne Mn in East Liverpool. S.H. Bell made a number of changes to operations to control Mn emissions at the company's East Liverpool facilities resulting from 2008 Findings and Orders from Ohio EPA. Some of these changes include:

- keeping dust down;
- enclosing parts of its operations; and
- covering trucks leaving the facilities;

Airborne Mn levels remained at unacceptable levels after the projects were completed. Ohio EPA determined that S.H. Bell needed to do more to control Mn dust. On February 8, 2010, Ohio EPA issued another set of "findings and orders." These findings and orders require S.H. Bell to:

- do more to keep dust down,
- stop handling Mn at the facility near East Elementary School;
- keep Mn out of the air by keeping it out of open air storage and loading areas; and
- keep very detailed records of efforts to reduce dust emissions.

Ohio EPA believes enforcing these steps will keep the airborne Mn concentrations significantly below the levels observed prior to these enforcement actions.

US EPA and Ohio EPA are committed to ensuring continued oversight of S.H. Bell, continued compliance with the Clean Air Act, Ohio Laws and regulations, these Findings and Orders, and continued ambient air monitoring.

What's Next?

As mentioned in the document title, these findings are preliminary. Ongoing data analysis may revise the conclusions slightly and may result in additional research. A website has been established that will provide a copy of the slides and fact sheet provided here today. This website will be updated with any new findings and publications. See: <http://www....> The website will become available the day after this community meeting.